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Technical development of production and products in organic tea farming

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Abstract: Technical development is necessary for overcoming some key pests and for providing economic management to organic tea growers. The cultivar TTES No. 12 is a satisfactory cultivar for organic tea farming (OTF) in Taiwan for its better resistance to pests. Infection of green leaf hopper tends to make the organic tea made having honey flavor. The key pest of OTF is tea mosquito bug. Long-term application of livestock organic fertilizer tends to accumulate high content of P and K in tea soils. Organic tea growers are recommended to apply oil-seed residues to lower down their nutrient input costs. Organic liquid fertilizers made from fermented soybeans with sugar, molasses. Microorganisms are used as auxiliary N supplements and as pest repellents by spraying on tea leaves regularly. To mitigate organic tea farmers' burdens in summer weeding, a hand- pushed and comb type weeding machine has been developed with low machine body weight and high efficiency in weeding. Organic tea products are quite diversely developed in Taiwan. Popular marketing of organic products includes green tea, oolong tea, black tea, GABA tea, Akai (red) oolong, honey flavor tea, green tea powder, and RTD tea etc.

Keywords: Organic tea farming; Tea cultivar; Tea pest control; Nutrient management; Organic tea product; Taiwan

Introduction

Tea is an important beverage next to coffee and cocoa in the world. Tea is another popular drink in the world besides water. Because of health benefits, tea is gradually accepted by consumers as natural health drink, especially in western countries. For the health and environmental concerns, most people prefer to drink organic tea. Organic tea in most countries is enforced by law. Over the past decades, its consumption has globally by more than 10% a year.[1] Naturally certified organic tea is the of most consumers who care about pesticide residue problems of tea.

Crops have to depend on nitrogen (N), phosphorus (P), potassium (K) and micronutrients for development and growth. Of these nutrients, P and K have to be mined deeply from P and K containing ore bodies, precious non-renewable resources.[2] The rocks will become deficient after 300-400 years, resulting in high prices P and K fertilizers.[3] Organic fertilizers containing P and K will be major sources for growing crops, including tea. Tea has to be dependent on recycled nutrients; mainly from organic fertilizers even if organic fertilizer prices are high. Recycling agricultural residues and integrated nutrient management are the truth of organic tea production.

Organic tea farming is a system in which organic fertilizers are applied instead of pesticides and chemical fertilizers.

In this system many common problems are encountered in the areas like costs, labor, pest control, organic nutrient inputs, weeding, tea manufacture techniques, certification, and marketing. The problems may vary from country to country or in areas within a country. Out of these problems, the pest control and nutrient management are the most commonly faced problems. Recent advances in pest control methods of organic tea cultivation in Japan had ever been discussed, a valuable knowledge sharing.[4]

Organic tea farming is an integrated production technology. In China, there is a reference book published, "Comprehension on Organic Tea Production".[5] In "Taiwan Organic Agriculture Technology Guidance", there are 11 chapters associated with organic tea farming, showing the importance of technological

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development of organic tea.[6]

For better organic tea production, technical development is necessary for overcoming some key pests, enhancing tea yields, and lowering down organic nutrient input and other management costs. Developing techniques for organic tea farming has become an important task for tea producing countries as gradual increase of world consumption on organic tea and farmers having better selling prices of organic tea. In this paper, recent development of organic tea technology and organic tea products, especially developed in Taiwan, have been discussed.

Organic Tea Production

The production of organic tea in the world is increasing at a very rapid rate. The organic tea produce area of some coun- tries is listed in Table 1.[7-10] India is a leading producer of organic black tea in the world. In 2010, India has produced 5,000 tons of organic tea per 6,000 ha of land.[1] The production level marks a twenty-fold increase in the ten-year period. In 2011, the organic tea area and production was 15,726 ha and 11,000 tons respectively. According to the incomplete statistics, the organic tea production of China, mainly organic green tea, is increasing at an average growth rate of 25% per year.[11] In 2010, the organic production areas of China reached 30,000 ha.[1] In Japan, the production of organic green tea is increasing annually. In 2009, the production of organic green tea was 1,873 tons constituting 2.18% of the total green tea production.[4] In 2014, the organic production amounted to 1,897 tons (Table 1).

Taiwan started its organic tea production in 1988, with governmental certification from 1996. The certification affair was handed over to civil certifying bodies in 2002. Currently, there are 13 organizations involved in the certification of organic tea (Plate I, Figure 1). The tea varieties like organic oolong, with organic green tea, organic oriental beauty and organic black were produced in small scale. (Plate I, Figures 2-5). The area under organic tea production during 1996-2013 is listed in Table 2.[12] The slow but stable growth of organic tea production during 1996-2007 was due to the freezing (disintegration) of the Taiwan Provincial Government, re-construction of agricultural organizations between the Council of Agriculture (COA) and Provincial

Table 1: Organic tea area and production in some countries

Country	Year	Area (ha)	Production (tons)	Sources
China	2011	40,000	35,000	7
India	2011	15,726	11,000	7
Turkey	2014	5,500	-	8
Japan	2014	-	1,897	9
Taiwan	2014	453	-	10

Table 2: Organic tea area in Taiwan11

Year	Area (ha)	Year	Area (ha)
1996	5	2005	72
1997	16	2006	71
1998	22	2007	125
1999	22	2008	140
2000	37	2009	169
2001	56	2010	219
2002	55	2011	263
2003	63	2012	408
2004	76	2013	447

Department of Agriculture and Forestry, and also the change of policy measures shifting from organic agriculture to traceability systems. After 2008, the production of organic tea grew tremendously due to the participation of organic tea production from the sectors of Buddhism bodies. This is especially true during 2011-2012. In 2013, Taiwan had 447 ha under organic tea production, with 229 households involved in the production. In 2013, Taiwan had 11,903 ha of land planted with tea. The organic tea area accounted for 3.8 % of total tea production area.

The development of Taiwan organic tea is well promoted by the Buddhism organizations such as Tzuchi, Tzuxin and Fofashan (Plate I, Figure 6). The Tzuchi and Fofashan own about 30 ha and 62 ha of organic tea farms, respectively. The Tzuxin has an organic tea factory and buys organic fresh tea leaves with better prices from the organic growers for processing. The distribution of organic tea area and household are listed in Table 3.[13] The major organic tea production is located in Nantou County (121 ha), New Taipei City (82.3 ha), Hualien County (69.2 ha), Miaoli County (61.2 ha) and Taichung City (42.4 ha), accounting for 84% of total organic tea production in Taiwan.

Table 3: Distribution of organic tea area in different county of Taiwan in 2013[12]

City/ County	Household	Area (ha)	City/ County	Household	Area (ha)
New Taipei	46	82.3	Yunlin	2	1.1
Taipei	10	6.0	Chayi	13	13.7
Taoyuan	8	10.2	Kaohsiung	4	5.1
Hsinchu	1	1.6	Pingtung	2	1.6
Miaoli	12	61.2	Yilan	15	13.0
Taichung	6	42.4	Hualien	6	69.2
Nantou	93	121.0	Taitung	11	18.7

Data based on "Taiwan Organic Information Portal 2014" (info.organic.tw)

Table 4: Disease and pest, and manufacture suitability of tea cultivars

Cultivar	Disease and pest resistance rating	Manufacture suitability	Remark
TTES No. 8	1	Organic black tea	Assam type
TTES No.18	2	Organic black tea	Assam type
TTES No.12	3	Organic Oolong	Chinese type
Suchichun	3	Organic Oolong	Chinese type
TTES No.13	4	Organic Oolong	Chinese type
Chinsin			
Dapan	5	Organic oriental	Chinese type
Chinsin		beauty	
Oolong	6	Organic Oolong	Chinese type

Technical development of organic tea production

Cultivar

Proper selection of cultivar is helpful to ensure pest control in organic tea farming. It can save non-chemical fees, and upgrade tea yields and manufacturing quality. The progress made in the organic green tea production shows that tea breeding is good for cultural control of pests.[7]

Two multiple-pest-resistant cultivars, "Yameka-ori" and "Saeakaori" were registered in 2006 and in 2010, respectively, being useful for organic tea cultivation in Japan.[4] In China, development of tea cultivars for organic tea production focuses on low N requirement and on tea pest resistance, especially resistance to tea green leafhopper.[14] If a cultivar has high N use efficiency, it would lower down the cost of organic fertilizer application. Recent pre-released clone by Kenya, TRFK 306/1, is a purple tea cultivar which is rich in anthocyanin and has high antioxidant capacity.[15]

The clone is drought, frost, disease and pest resistant, qualified for making specialty tea – organic purple tea.

In Taiwan, consumers' preference for Oolong tea is in the following cultivar order: Chinsin Oolong, TTES No. 12 (Chin Hsien), TTES No. 13 (Jade Oolong), Suchichun and Chinsin Dapan. However, Chinsin Oolong has the weakest capability in pest resistance. As listed in Table 4, the suitable Oolong cultivars for organic tea cultivation are TTES No.12, TTES No.13 and Suchichun (Four Season Spring). The newly released cultivar in 2004, TTES No. 19 and TTES No. 20 are also useful cultivars for organic production for its drought, disease and insect resistance (Plate II, Figure1). The aroma and flavor for the tea made is close to Chin Hsien and Chinsin Oolong, respectively. Recent experiments conducted by the Taiwan Tea Research and Extension Station (TTRES) shows that TTES No.17 is a useful cultivar for making organic black tea. Generally speaking, broad leafy varieties such as Assam-type tea (TTES Nos. 8 and 18) have the best pest resistant capability, suitable for making organic black tea (Plate II, Figure 2). In Taiwan, wild tea growing in mountains, with no pesticide and fertilizer applied, has become a target selection for making organic tea. There is a tendency that local consumers like to buy organic wild tea for it's special aroma and flavor, even if priced high.

Weeding

Since chemical weeding is not allowed to be used in organic tea farming, weeding is sometimes a serious problem to some organic tea growers if the shading of their tree canopy cannot suppress weed growth, both in winter or in summer. In cultivation stage of young tea plants, weed control is also a problem (Plate II, Figure 3). Weeding wages in Taiwan's tea gardens are very high. Usually it costs farmers to pay US$11 an hour to hire a weeding laborer. Tea growers are encouraged to build a good tree canopy to inhibit grass growth between tea rows (Plate II, Figure 4). Quite a few farmers pave plastic mats on the tea rows or grow perennial peanut to control weeds (Plate II, Figure 5). Most farmers use shoulder-mount mowers (hard pipe) to mow weeds. Machine noise, vibration and weight are the disadvantages of this kind of mower. Due to the price problem, a shelf-propelled mower is not a common machine used in organic tea farming. It may result in dust pollution on fresh tea leaves when soil is dry. The weight of the mower is also a problem for a female worker to handle. Most farmers have to conduct frequent weeding in rainy season. In addition, the climatic change often causes quite high temperature in summer (>35°C). Hot summer often prevents growers from working on farms for too long. To reduce the labor burden of farmers, a light (15 kg) comb-type weeding machine (Plate II, Figure6) was developed by the Taiwan Agricultural Research Institute (TARI) to upgrade weeding efficiency, saving three-fold weeding time as compared to a shoulder-mount mower. However, the machine can only be used in flat tea gardens with no stony soils. This machine is good for sod culture in which short grass is maintained.

In addition to labor shortage, another weeding problem in Taiwan is the intrusion of foreign weeds, Pilose beggarticks, or called as Spanish needles (*Bidens Pilosa* var. radiata), into tea gardens (Plate II, Figure 7). The flowers of the weeds blossom two times a year (summer and winter), being a good source of honey for bees in winter. The weed seeds were introduced by bee raisers from Okinawa, Japan, spraying along the free ways. The intrusion and multiplication of the weeds are especially serious in organic tea gardens because chemical weeding is not allowed in the gardens. The light needles-type seeds of the flowers make fast and far-distance proliferation of the weeds (Plate II, Figure 8). Extra labor has to be spent to get rid of the weeds, particularly the underground part of root systems.

Organic tea farming tends to have shade-tolerant weeds growing underneath the tea plants or extending over tea canopy. The weeds are mostly broad-leafy. Hand-pull or removal by a small tooth harrow is the common way to solve the weed problem.

Disease and pest control

Disease and pest control are usually a headache to organic tea growers, especially the pest problems. Major diseases, insect pests and mites of tea cultivation vary from country to country and it also varies area as well as years too within a country. In Japan, anthracnose, bacterial shoot blight and gray blight are the types of diseases. Major insect and mite problems cover white peach scale, tea green leafhbeopper, tea leaf roller, Kanzawa spider mite, smaller tea tortix and oriental tea tortrix.[4] In Jeju island of Korea, major pest problems are similar to that of Japan, except that they are also damaged from yellow tea thrips.[16] In the past 20 years, under the pressure of pesticide spray, the key tea pests of Taiwan have shifted from the large size pests (tea cluster caterpillar, tea bag-worm, looper caterpillar) to small size with short life-cycle pests such as green leafhoppers, tea leaf rollers, yellow tea thrips, spiny white-fly and mites etc.[17]

Table 5: Effect of non-chemical material on tea sensory evaluation12

Days after spray	Sunflower sapindus Oil (diluted 200 fold)	Chili powder etc. (diluted 300 fold)	Narow range oil (diluted 300 fold)	CK (water)
0	2.50*	1.50	2.00	0
3	0.25*	1.00	1.25	0
7	0.25*	1.00	0.50	0
14	1.00*	0.50	1.00	0

*0 - Stand for no odd-odor; 1-light odd-odor; 2-intermediate odd-odor; 3-heavy odd-odor.

Because synthesized chemical pesticides are not allowed to sprayed during organic cultivation, the insect pest ecology in organic tea gardens is different from that of conventional farming. Tea bag-worms, yellow tea thrips, tea cluster caterpillars are the insect pests sometimes found in organic tea gardens of low altitude in Taiwan. The tea mosquito bug has been the most destructive pest in the organic tea gardens adjacent to the forest (Plate II, Figure 9). However, similar to conventional tea growers, few organic tea growers have problems with reactions to diseases.

In 1990s, in the early stage of organic tea development in Taiwan, techniques of biological control developed by the TTRES were most recommended to local organic growers for pest control. These included applications of sex pheromone to control tea tortrix and black tea tortix, the use of lacewings (aphid lions) to control small size tea pests such as green leafhopper, spider mites, Kanzawa mite and spiny white-fly and applications of predator mites (*Amlysieus womersleyi*) to control tea mites and Kanzawa mites. Techniques of parasitoid control on eggs of tea cluster caterpillars and tea tortrixes were also taught to organic tea growers. *Bacillus thuringiensis* was used to control the population of lepidoptera such as tea cluster caterpillars, tea tortrixes, tea bag-worms, tea moths and tea loopers. To conduct biological control, most prevention materials required acquisition costs and installation labors and thus resulted in a low number of users. According to the survey made by the TTRES *Bacillus thuringiensis* was the control materials widely used in the organic tea production of Mingjian, an important tea area in Taiwan.[18] It may be due to facilitating application and multiple effects like Spray of non-chemical materials such as sunflower oil, chili powder extract and narrow range oil etc., can lower the population of small size tea pests. However, this resulted in an odd-odor of tea.[17] The odd-odor disappeared with days after spraying (up to 7 days). In 14 days after spraying odd-odor still existed according to tea sensory

Because of quite serious labor shortage in Taiwan, there is a clear tendency that pest control of organic tea growers has shifted from the installation of biological control materials to spraying liquid type or solid type controlling materials, with power sprayers. Experimental results show that the compost tea made from infused tea leaves, tobacco debris (dust) and mushroom compost could decrease the population of green leafhoppers and spiny white-flies in organic tea gardens.[19] An LED lamp is energy-saving and has a long-life. With the application of a photovoltaic panel, it can get access to the energy of self-sufficiency. Conducting dark room trapping on tea mosquito bugs with a wind tunnel and 5 colors of LED light (red, yellow, white, blue and UV light) revealed that the trapping capability for the color of LED light was in the following order: UV>blue>red>yellow>white.20 However, the tea mosquito bugs usually show up during the evening. Field trapping alone for the bugs may not function well. Combined with LED lights it improved and lured insects to the boxes to catch tea tortrix at night indicating that the LED light ability to catch by color is in the following order: UV>blue>white>yellow>red.[20]

In Taiwan, there are three methods adopted by the organic tea growers. The first method is to just disregard the pest problems, with no measures to control the pests. In such cases, tea yields are often low, nearly having no harvest resulting in low tea quality but with high prices for tea sold. These kinds of growers are not many. Based on experiences shared by such farmers, after one tolerates a 3 year crop failure, the pest problems will reduce owing to ecological balance as well as pest resistance and this results in an increase in organic tea yield.

The organic tea growers adopting the second method of pest control conduct traditional operations of pest control except the fact that they do not spray soybean- fermented solution (SYS, microbial broth) as repellents and nutritional supplements. Traditional operations of pest control include spray of *Bacillus thuringien- sis*, installation of yellow sticky boards, and applying diluted extracts of garlic and capsicum (hot pepper) etc.

The organic tea growers who implement the SYS spray are categorized as adopting the third method of pest control. The SYS is the fermented solution prepared from soybeans, sugar, molasses and specific microorganisms cultivated by Professor T. C. Tsai of National Chung Hsing University. The number of growers adopting the third method is increasing owing to the advantage in suppressing pests, upgrading tea yields and better quality of tea.

Organic tea farming tends to have lower incidence of green leafhopper attack as compared to the conventional farming. It seems that the green leafhopper is not an important pest in organic tea

farming of Taiwan. Most organic growers treat the hoppers as beneficiary insects. If farmers fields have green leafhopper infection, they will grow honey flavor tea such as oriental beauty, oolong and black tea, with natural honey flavor. This is contrary to the anticipation by most tea growers of the world. The reasons why the OTF has low incidence of hopper attack is still under investigation from the aspect of predator built-up, alteration of weed ecology and SYS spraying obstruction on the hoppers.

In Taiwan Organic tea production, mosquito bug is a bothersome problem. For the tea gardens adjacent to forests, tea mosquito bugs are a serious problem to the OTF as the bugs hide in the forest, bait on the tea leaves and then migrate away. Leaf growth becomes stunted and necrotic spots appear on the tea leaves. Thus odd-odor of tea arises and it lacks marketing value. Unlike traditional tea farming, it is quite hard to use non- chemical control to inhibit the population of the bugs. Farmers are suggested to monitor the infection level in the field, to conduct black plucking, to control weeds and to remove stalks containing bug eggs as important cultivar measures. Damage by the bugs can be contained by killing the bug eggs on the tea leaves. Farmers by experience have realised that sunflower seed oil mised with natural emulsifying agents such as soapberry solution can suppress the eggs laid by mosquito bugs. (Plate II, Figure 10). The bug damage on the tea leaves can be reduced. The extracted solution of garlic, hot pepper and vinegar is used by many organic tea growers to control the small tea pests such as thrips, aphids and green leafhoppers etc. (Plate II, Figures 11-12). "In Japan, innovative machines for suctioning in or blowing away of tea pest insects were invented by two companies. However, the prices are too high for Taiwanese tea growers to buy it because of self-propelled types."

Nutrient Management

Nutrient management is important as the organic tea production is closely associated with tea yields, tea quality and costs. One of the aims for organic tea cultivation is to recycle agricultural residues. Organic fertilizers have to be used in the tea farm instead of chemical fertilizers. In Taiwan, the public sectors tend to encourage organic tea growers to use livestock organic fertilizers combined with over 60% organic matter, hoping to improve soil chemical and physical activities while solving the problems of livestock excrement due to so many entrepreneurial raising of chickens and pigs. However, long-term application of livestock manure led to an increase in soil pH, well as soil calcium and magnesium levels.[21] Since a large amount of organic fertilizers have to be applied to the soils yearly for the sake of low N in the livestock organic fertilizers, tea soils may become high in organic matter, phosphorus and potassium levels. The soil survey made by TTRES on 102 organic tea gardens shoed that most of the gardens had organic matter content over 4% (the abundant level).[22] Lowering down the organic fertilizer inputs were suggested to the organic growers. If the soil pH is greater than 6.0, it is not suitable for tea growth. In terms of costs, continued inputs of organic fertilizers into tea gardens would be heavy burdens to organic tea growers. In such case, farmers are recommended to apply some oil-seed residues which are high in nitrogen and can save farmers' money. Pellet-types of organic fertilizers made with oil-seed residues and fermented livestock manure are current favorite organic fertilizers to the organic tea growers for its high N contents and easy application, even in hilly tea gardens.

Remedy foliar application of fermented solution by use of oil-seed residues and microorganism has become a common management approach to upgrading growth vigor of organic fresh leaves (Plate II, Figure 13). This apparently can lower down organic fertilizer applica- tion costs. However, care has to be taken not to apply the foliar organic fertilizers 20 days before tea picking. Otherwise it may get odd-odor tea made.

Green manure crops are helpful in controlling weeds and supplying additional nitrogen to the organic tea soil. However, owing to labor shortage, quite a few organic growers in Taiwan adopt it. Screening of green manure crops shows that yellow lupine is a good green manure crop in winter for its tolerance to acidic soil and cold winter, and high bio-mass. Lupine is suitable for north tea cultivation in Taiwan because winter is moist there, and it can be used as a scenic crop for sightseeing also (Plate II, Figure 14). Central-south tea areas tend to have a dry winter; it is not an appropriate season for lupine to grow. The suitable green manure crop in summer is sesbania and green soybean. However due to extra costs of plowing the manure crops into soils and hindrance of tea plucking, quite limited organic growers use it.

Tea manufacture

Tea manufacture is an important step for the better quality of organic tea produced. For organic tea manufacture, it is slightly harder than conventional tea manufacture because sometimes the fresh tea leaves have certain degree of pest infection and unbalance inputs of nutrients through application of organic fertilizer. If the fresh tea leaves of organic cultivation are not qualified for making lightly-fermented oolong, it is suggested to make intermediately fermented or roasted oolong instead. Making organic black tea is market and are seasonally oriented. If there is green leafhopper infection on the organic fresh tea leaves, it is suggested to make honey flavor tea, such as oriental beauty and honey black tea. PPO (polyphenol oxidase) is related to the fermentation capacity of tea leaves. Experiments had revealed that after 6 hours of fresh tea leaf picking, the activity of PPO in tea shoots damaged by tea green leafhoppers took on a big raise, and then increase fluctuated, and dropped to minimum around 0:00 next day. After that, the activity of the PPO entered the next fluctuating cycle.[23] A Taiwanese report indicates that there was higher catechin level in fresh tea leaves infected with green leafhopper as compared to that of healthy tea leaves.[24] Most tea growers feel that growing organic oolong tea will turn to brown tea soup when brewed. In Taiwan, tea with golden tea soup usually has higher market value as compared to that of brown tea soup as the former has better aroma and flavor. To make organic oolong tea, farmers need to use light degree and short duration of stirring in order to avoid generating brown tea soup. To prevent mixing with conventional tea nd also to rule out pesticide residue contamination, the organic growers need to use seperate manufacturing machines to process tea.

Development of multiple organic tea products

Tea is a hobby line product. To meet consumer requirements, many kinds of organic tea products are introduced by organic tea growers and commercial companies. Organic tea products in Taiwan are very versatile. This is due to the variations in seasons, producers, locations, elevations and manufactures and market requirements. Most organic tea growers are small producers. In order to obtain more incomes, they have to create additional value for organic tea. Nearly all organic tea growers sell their tea directly to consumers, especially to their actual buyers. Therefore, to offer more selections for the consumers, they provide many different kinds of tea including roasted organic oolong. Usually, farmers use spring, the first summer, autumn and winter crops to manufacture oolong tea. Oolong tea is Taiwan's bulk organic tea production with aroma and flavor varying from grower to grower, which is called tea French fry in Taiwan (Plate III, Figure 1). To prepare this tea food, one has to mix tea leaves with wheat flour and eggs.

The second summer crop is mostly used by farmers to grow organic black tea. In recent years, black tea grown using small leafy varieties is quite enjoyed by local consumers, especially oolong-type black tea with deep degree of fermentation. In addition, famed organic black tea made by use of Assam-type variety, TTES No. 18, is located in Puli, Yuchi and Minchien tea areas.

In Japan, the direct selling situation of organic tea growers is similar to that of Taiwan. In addition to organic green tea produced, some of them produce organic oolong, black tea, and brown rice tea too. Organic Benihuki oolong or black tea is found in the market. One Japanese company has organic tea congee (gruel) and kelp tea prepared by roasted organic green tea blended with kelp and organic rice, respectively. Microbial fermented tea named Yamabuki-nadeshiko (Japanese Beauty) containing teadenol A and teadenol B is prepared from organic green tea and is promoted by Osada Seincha company.[25]

GABA tea is a health protector tea which contains high contents of gamma butyric amino acid (GABA) which has been proven to lower blood pressure. In Taiwan, there are several organic GABA tea producers, located in Minchien and Pilin respectively. The organic GABA has become an export products, especially consumed by EU and USA people (Plate III, Figure 2). PET bottles of organic GABA tea are also circulating in the market although its price is a little bit higher than regular PET tea drinks.

Organic tea is a very good material for preparing multiple tea products as it contains no pesticide residue. It can protect consumers' health. Taiwan produces many products from tea such as Pounded tea (Leicha), tea wine, tea noodle, tea tablet and constelaltion tea etc. (Plate III, Figures 3-7).

There are three Buddhism organizations in Taiwan, Fofashan (Buddha Arma Mountain), Tzuxin, and Tzuchi, contributing greatly to the development

of organic tea in Taiwan. All the groups have their organic business affairs, promoting and selling organic tea products ranging from organic white tea to black tea, tea bags included. The groups have quite good entre- preneurship spirit to manage the organic farm and business on they own. They have succesfully developed diverse organic tea products. International organic tea trad- ing is also promoted by all the groups. The Buddha Arma Mountain held organic tea contests three times alongwith the co-sponsorship of the Association of Taiwan Tea.

Taiwan produces fairly a good quantity of organic green tea with just 20 professional growers who are distributed across Shanhsia, Yilan, Hsinchu and Taitung. The Shanhsia grown organic tea is the traditional Bilochuan, a strip type green tea. In other tea growing areas, growers use spring crop to get a better tasting quality tea. There are several growers producing organic green tea powder.

If the fresh organic tea leaves are infected by green leafhoppers, oriental beauty tea or honey flavor oolong are made either in Taoyuan, Hsinchu and Miaoli tea areas or in other tea areas. High grade of organic black tea with honey flavor is a product in summer. Organic green tea with honey flavor originated in Taitung and is a rare tea in the market. Taitung tea area is also noted for its red (Akai) oolong production. Red oolong is processed by deep stirring and fermentation of fresh tea leaves, this results in green leaves with red edge. The tea is oolong when brewed with cold water and turns to black tea with hot water. The tea developed was intended to create a market segment for local mountain tea and import tea. The tea got its name from the red brown color of tea soup. There are several organic red oolong producers.

In Pinlin tea areas, the dominant organic tea is Baochung tea whose degree of fermentation is lighter than that of oolong and which has flowery flavor. Rare teas of this area produced include organic mountain tea, organic purple black tea, and organic Tehquanyin tea. In 2014 there were 25 organic tea growers. Through the promotion of Tzuxin Foundation, a Buddhism society, the Pinlin organic tea areas have been developed into a place of eco-tourism for people living in Northern Taipei area to experience organic tea farming and man- ufacture (Plate III, Figure 8). A one-day trip to the area is quite enjoyed by people. Other similar sites of organic tea tour are Fofashan organic tea garden (located in Pinlin, Rehswei and Takun, respectively) and Tzuchi Organic Tea garden. These activities are profoundly helpful while marketing organic tea.

In Taiwan, organic RTD tea (oolong) was first launched to the market by two local companies. However, one company failed to develop their market. In the USA, organic bever- ages such as Honest Tea, have plenty of varieties of pure organic tea or tea beverage flavored with specific fruit juice such as mango, nectar, and peach etc.[26] Trader Joe's of USA has two kinds of organic tea drinks, organic green tea lemonade and organic green tea pomegranate. Apparently, organic tea flavored with fruit juice is well received by the US consumers. In Japan, there is organic RTD tea also, such as Suntory black oolong and Uji organic tea.

In China, organic tea products are many ranging from white tea to black tea. It totally covers the six kinds of tea in China. A special organic tea product is the organic craft tea, with hand sewing of flower-shape tea into bundles or rosettes by artisans. When the tea is steeped in hot water, it slowly blossoms into a bouquet of breathtaking shapes with exquisite flavor. Deep processing of organic tea is China's strength. Famous organic products are organic tea extracts such as catechin and theatine.

In Sri Lanka, the organic black tea or green tea labeled with Fair-Trade and/or Rainforest logos is gradually being accepted by consumers. The purposes of such activity is to support the original producers and to protect our environment. Sri Lanka's organic tea is noted for its attractive packaging and export quality.

Conclusion

Agricultural waste can be recycled as organic fertilizer owing to organic tea cultivation and also for protecting the environment, human health while maintaining ecological balance.To achieve this goal, producers, consumers, researchers and all others need to collaborate. Integrated management practice has to be adopted in pest control and nutrient management with special focus to developing light weight and low cost products which can be managed conveniently with less labor and low cost materials. Developing diverse organic tea products which are affordable and appeal to consumers while benefitting organic tea growers or manufacturers.

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